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Author: Chen Zhong Ed Manley Stefan Muller Arisona Michael Batty Gerhard Schmitt

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Measuring Variability of Mobility Patterns from Multiday Smart-card Data

Chen Zhong[1, 2], Ed Manley[1], Stefan Muller Arisona[2, 3], Michael Batty[1], and Gerhard Schmitt[2]

[1]*Central for Advanced Spatial Analysis, University College London, U.K.*
[2]*Future Cities Laboratory, Architecture department, ETH Zurich, Switzerland.*
[3] *Institute of 4D Technologies, FHNW, Switzerland*
{c.zhong, ed.manley, m.batty}@ucl.ac.uk.com, stefan.arisona@fhnw.ch, schmitt@arch.ethz.ch

Abstract

The availability of large amounts of mobility data has stimulated the research in discovering patterns and understanding regularities. Comparatively, less attention has been paid to the study of variability, which, however, has been argued as equally important as regularities, since variability identifies diversity. In a transport network, variability exists from person to person, from place to place, and from day to day. In this paper, we present a set of measuring of variability at individual and aggregated levels using multi-day smart-card data. Statistical analysis, correlation matrix and network-based clustering methods are applied and potential use of measured results for urban applications are also discussed. We take Singapore as a case study and use one-week smart-card data for analysis. An interesting finding is that though the number of trips and mobility patterns varies from day to day, the overall spatial structure of urban movement always remains the same throughout a week. This finding showed that a systemic framework with well-organized analytical methods is indeed necessary for extracting variability that may change at different levels and consequently for uncovering different aspects of dynamics, namely transit, social and urban dynamics. We consider this paper as a tentative work towards such generic framework for measuring variability and it can be used as a reference for other research work in such a direction.

Keywords: Variability, smart-card data, spatial analysis, clustering, network

1 Introduction

There is a rapid rise of interests in data-related research in recent years, mostly because that never before has it been so easy to collect such cheap and large amounts of mobility data in fairly good spatiotemporal resolution. Research that depended on simulated data for discovery universal human mobility patterns (Szell et al., 2012), can now use real-world data as alternatives due to abundant large data sets generated by human agents. The human mobility data enables us to have a closer and more direct look into spatiotemporal patterns of human mobility (Agard et al., 2006; Liang et al., 2009; Zhong, Huang, et al., 2014), and regularities and/or scaling laws (Gonzalez et al., 2008; Schneider et al., 2013; Simini et al., 2012; Song et al., 2010).

Equally important as regularities is the variability, which however, has received much less attention comparatively. Jones and Clarke (1988) once discussed the significance of variability. In